FORMULAE FOR AMOUNTS, NUMBER OF PARTICLES, MASS, CONCENTRATION OR VOLUME

Measure	Amount	Mass	Volume	Concentration	No. of Particle
Symbol	n	m	V	c	
Unit	mol	gram, g	Litre, L	Molarity, M	
Formula	$n = c \times V = \frac{m}{Mr} = \frac{\text{No of Particles}}{Na}$	$m = n \times Mr$	$V = \frac{n}{c}$	$c = \frac{n}{V}$	$n \times N_A$ where $N_A = 6.02 \times$

FORMULAE FOR CONVERTING BETWEEN DIFFERENT MEASUREMENTS

Determine the Mass of Solute given the Concentration and Volume of the Solution.

Step 1: Convert the Concentration and Volume (in L) into the Amount in mol, using **n(solute) = Concentration x Volume**.

Step 2. Convert the Amount in mol into Mass using **m(solute) = Amount (in mol) x Molecular Mass**.

Determine the Mass of Solute given the Number of Particles.

Step 1: Convert the Number of Particles into the Amount in mol using **n(solute) = Number of Particles / Avogadros Constant** .

Step 2. Convert the Amount in mol into Mass using **m(solute) = Amount (in mol) x Molecular Mass**.

Determine the Number of Atoms present in a solution of a known Volume and Concentration.

Step 1: Convert the Concentration and Volume (in L) into the Amount in mol using **n(solute) = Concentration x Volume**.

Step 2. Convert the Amount in mol into Number of Atoms using **Number = Amount (in mol) x Number of atoms in 1 molecule x 6.02 x 10^{23}.**

Determine the Number of Atoms present in a certain mass of solute.

Step 1: Convert the Mass of solute into the Amount in mol using $\mathbf{n(solute) = \frac{Mass\ of\ Solute\ [m]}{Molecular\ Mass\ [Mr]}}$.

Step 2. Convert the Amount in mol into Number of Atoms using **Number = Amount (in mol) x Number of atoms in 1 molecule x 6.02 x 10^{23}.**

Determine the Concentration of a Solution using the Mass of Solute and the Volume of the Solution.

Step 1: Convert the Mass into the Amount in mol using $\mathbf{n(solute) = \frac{Mass\ of\ Solute\ [m]}{Molecular\ Mass\ [Mr]}}$.

Step 2. Convert the Amount in mol into Concentration using $\mathbf{[solute] = \frac{Amount\ [n]}{Volume\ [V]}}$. The Volume must be in L.

Determine the Volume of a Solution using the Mass of Solute and the Concentration of the Solution.

Step 1: Convert the Mass into the Amount in mol using $\mathbf{n(solute) = \frac{Mass\ of\ Solute\ [m]}{Molecular\ Mass\ [Mr]}}$.

Step 2. Convert the Amount in mol into Volume using $\mathbf{V(solution) = \frac{Amount\ [n]}{Concentration\ [c]}}$.

Determine the Concentration of a Solution after it has been DILUTED to a new volume.

Step 1: Convert the original Concentration and Volume into the Amount using **n(solute) = Concentration x Volume.**

If solutions with the same solute are mixed, then add their Amounts (in mol) together and do step 2

Step 2: Convert the Amount in mol into the new Concentration using: $\mathbf{[solute] = \frac{Amount\ [n]}{Final\ Volume\ [V]}}$.

UNIT CONVERSIONS

To Convert; mL --> L, divide by 1000. Tonne --> kg, multiply by 1000. kg --> g, multiply by 1000

mg --> g, divide by 1000

ATOMIC MASSES OF COMMON ELEMENTS:

Element	Atomic Mass	Element	Atomic Mass	Element	Atomic Mass	Element	Atom Mas
Hydrogen, H	1	Lithium, Li	7	Carbon, C	12	Nitrogen, N	14
Oxygen, O	16	Fluorine, F	19	Sodium, Na	23	Magnesium, Mg	24.3
Aluminium, Al	27	Phosphorus, P	31	Sulfur	32	Chlorine, Cl	35.5
Potassium, K	39	Calcium, Ca	40	Chromium, Cr	52	Iron, Fe	56
Nickel, Ni	58	Copper, Cu	63.5	Zinc, Zn	65.4	Silver, Ag	108
Tin, Sn	119	Iodine, I	127	Lead, Pb	207		

UNIT 2 **CHEMICAL AMOUNTS REVISION I QUESTIONS** **CHEMISTRY**

1. Amounts of chemicals in Chemistry are usually measured in:-
A. numbers. B. mass in kilograms. C. amount in mol. D. volume in mL.

2. In the following list, the substance that contains the greatest number of atoms is:
A. NH_4NO_3. B. $CuSO_4$. C. $Al_2(SO_4)_3$. D. H_3PO_4.

3. In the following list, the substance with the greatest number of particles (atoms or ions) is:-
A. 12 g of ^{12}C. B. 100 mL of 1.0 M HCl. C. 6.02 x 10^{22} Li^+ ions. D. 1.0 mol of O_2.

4. The number of particles in 1 molecule of $Fe_3(PO_4)_2$ is:-
A. 5. B. 11. C. 13. D. 8.

5. Avogadro's Law states:
A. that no atoms can be created or destroyed. B. all atoms have the same mass relative to Carbon, 12.
C. there are 6.02 x 10^{23} of particles in 1 mol of any substance. D. the Relative Atomic Mass of atoms is related to Carbon, 12.

6. The Relative Molecular Mass of $Al_2(SO_4)_3$ (Ar(Al) = 27, Ar(O) = 16, Ar(S) = 32) is:-
A. 123. B. 150. C. 342. D. 315.

7. If the Empirical Formula of a Hydrocarbon is CH_3 and the Molecular Mass is 30, then the Molecular Formula is:-
A. C_3H_9. B. CH_3. C. C_2H_4. D. C_2H_6.

8. The % by mass of Aluminium in $Al(OH)_3$ (Ar(Al) = 27, Ar(O) = 16, Ar(H) = 1) is:-
A. 61.4 %. B. 44.3 %. C. 34.6 %. D. 25.4 %.

9. At the start of the reaction, $Na_2CO_3(s) + 2\ HCl(aq) \rightarrow 2\ NaCl(aq) + CO_2(g) + H_2O(l)$, there is 0.020 mol of HCl present. It is therefore expected that:-
A. 0.020 mol of Na_2CO_3 will react. B. 0.020 mol of CO_2 will be produced.
C. 0.040 mol of Na_2CO_3 will react. D. 0.010 mol of CO_2 will be produced.

10. The amount in mol of 10.0 g of $CaCO_3$ (Ar(Ca) = 40, Ar(C) = 12, Ar(O) = 16) is:-
A. 0.10 mol. B. 0.01 mol. C. 0.19 mol. D. 0.02 mol.

11. The mass of Sodium Hydroxide present in 250 mL of 0.20 M NaOH solution is:-
A. 0.050 g. B. 1.0 g. C. 0.10 g. D. 2.0 g.

12. The empirical formula of a chemical with 2.74 % hydrogen and the rest chlorine (Ar(H) = 1, Ar(Cl) = 35.5) is:-

A. H_2Cl. B. HCl C. HCl_2. D. H_2Cl_2.

13. Determine the amount in mol of:

a). 2.0 g of Helium. b). 1.0 L of 2.0 M HCl. c). 1.2 x 10^{24} particles. d). 2.0 g of $Ca(OH)_2$.

e). 125 mL of 0.40 M NaOH. f). 2.0 x 10^{23} NaOH particles. g). 6.0 g of LiOH.

14. Calculate the concentration of solute in 200 mL of a solution containing 0.10 mol of Sodium Hydroxide.

15. Calculate the mass of solute in 200 mL of a 0.10 M solution of Sodium Hydroxide.

16. Calculate the mass of solute present in: a). 6.02 x 10^{22} $CaCO_3$ molecules. b). 150 mL of 0.400 M HCl solution.

17. Determine % by mass of each element and the molecular mass of a). C_4H_{10}. b). $CuSO_4$. c). NH

18. Determine the molecular formula of a substance containing 83.3% C and 16.6% H whose molecular mass is 72.

19. Write the empirical formula for each of the following: a). C_4H_{10}. b). C_3H_8. c). NH

20. Ammonia is prepared by the following reaction: $Ca(OH)_2(s) + 2\ NH_4Cl(s) \rightarrow CaCl_2(s) + 2\ NH_3(g) + 2\ H_2O(l)$

a). Calculate the mass of ammonia (NH_3) produced from 10.7 g of NH_4Cl.

b). What mass of calcium hydroxide is needed to react with 5.35 g of NH_4Cl.

21. A precipitate of Silver can be prepared according to the reaction: $AgNO_3(aq) + NH_4Cl(aq) \rightarrow AgCl(s) + NH_4NO_3(aq)$

a). Determine the mass of AgCl precipitated using 200 mL of 0.200 M $AgNO_3$ solution (Ar(Ag) = 108, Ar(Cl) = 35.5).

b). If 0.200 mol of $AgNO_3$ and 0.300 mol of NH_4Cl is initially placed in the reaction chamber, determine the limiting reactant and therefore determine the amount and mass of Silver Chloride that will be produced.

Multiple Choice Answers: 1. C. 2. C. 3. D. 4. C. 5. C. 6. C. 7. D. 8. C. 9. D. 10. A. 11. D. 12. B.

13a). 0.5 mol b). 2.0 mol. c). 2.0 mol. d). 2.7 x 10^{-2} mol. e). 0.05 mol. f). 0.33 mol. g). 0.25 mol. 14. 0.5 M. 15. 0.80 g. 16a). 10.0 g. b). 2.19 g.

17. a). %C = 82.8 %, %H = 17.2 %, 58. b). %Cu = 39.8 %, %S = 20%, %O = 40.2%, 159.5. c). %N = 35%, %H = 5%, %O = 60%, 80.

18. C_5H_{12}. 19. a). C_2H_5. b). C_3H_8. c). NH_2O. 20a). 3.4 g. b). 3.7 g. 21a). 5.74 g. b). 0.200 mol AgCl, 28.7 g.

UNIT 2 **CHEMICAL AMOUNTS REVISION II QUESTIONS** **CHEMISTRY**

1. Use mol formula to fill in the following table:-
Ar(Na) = 23, Ar(Cu) = 63.5, Ar(Ag) = 108, Ar(Cl) = 35.5, Ar(H) = 1, Ar(O) = 16, Ar(C) = 12, Ar(S) = 32, Ar(N) = 14.

Item	Amount in mol	Mass of Solute	Volume of Solution	Concentration of Solute
a).	1.00 mol of NaCl solute			0.100 M NaCl solution
b).		1.70 g of $AgNO_3$ solute		1.0 M $AgNO_3$ solution
c).			150 mL of NaOH solution	0.60 M NaOH solution
d).	0.020 mol of $CuSO_4$ solute		0.250 L of $CuSO_4$ solution	
e).		31.0 g of Na_2O solute	400 mL of Na_2O solution	
f).			1.20 L of NH_3 solution	0.20 M NH_3 solution

2. When solving stoichiometry questions:-

step 1. write a balanced equation (with states). *The coefficients give a whole number mol ratio of the reactants and products*. eg. **2** Mg(s) + **1** O_2(g) ---> **2** MgO(s) means that we can have:-

0.2 mol **0.1** mol **0.2** mol OR

0.1 mol **0.05** mol **0.1** mol OR

any other amounts in mol as long as they have the same ratios as the coefficients in the equation.

If the reaction equation is not properly balanced, the answers to the stoichiometry questions cannot be correctly determined.

step 2. convert the measurements known about a chemical into mol using a mol formulae.

$n\ (solute) = \frac{Mass:\ m\ in\ g}{Molecular\ Mass:\ Mr}$, *n (solute in solution) = C (in M or mol/L) x V (in L), n (solute) =* $\frac{\text{No. of Particles}}{\text{Avogadros Const : } 6.0223\text{x}10^{23}}$

n (gas) = $\frac{\text{Pressure: P in kPa x Volume: V in L}}{\text{Gas Const: R [8.31] x Temp: T in K}}$ or $\frac{\text{Volume : V in L}}{\text{Molar Volume, } V_m \text{ in Lmol}^{-1}}$ *where Vm = 22.4 L at S.T.P. (273K and 101.325 kPa).*

step 3. then use the coefficients in the balanced equation to find the mol of the required chemical using:-

n(What you want) = $\frac{\text{Coefficient of Chemical Wanted}}{\text{Coefficient of Chemical Known}}$ **x n(Chemical Known)**

step 4. and then convert this mol into the required unit by rearranging a mol formula.

In the precipitation reaction: Silver Nitrate ($AgNO_3$) solution reacts with Copper Chloride ($CuCl_2$) solution, according to the reaction equation: **2** $AgNO_3$(aq) + **1** $CuCl_2$(aq) ---> **1** $Cu(NO_3)_2$(aq) + **2** AgCl(s).
Ar(Ag) = 108, Ar(N) = 14, Ar(O) = 16, Ar(Cu) = 63.5 and Ar(Cl) = 35.5

a). In a particular experiment, **2.0** mol of pure Silver Nitrate reacts. What amount of Copper Chloride (in mol) should react?

b). In another experiment, **0.20** mol of pure Silver Nitrate reacts. What amount of Copper Chloride (in mol) should react?

c). In another experiment, **0.30** mol of pure Silver Nitrate reacts. What amount of Copper Chloride (in mol) should react?

d). In another experiment, **0.40** mol of Copper Chloride reacts. What amount of Silver Chloride (in mol) should be produced?

e). In another experiment, **0.400** mol of Copper Chloride reacts. What mass of Silver Nitrate should react?

Hint: Find the amount in mol of Silver Nitrate and then rearrange $n = \frac{Mass:\ m\ in\ g}{Molecular\ Mass:\ Mr}$ to find the mass of Silver Nitrate.

f). In another experiment, **0.3000** mol of Silver Nitrate reacts. What mass of Copper Chloride should react?

g). In another experiment, **0.1000** mol of Silver Nitrate reacts. What mass of Silver Chloride should be produced?

h). In another experiment, **1.43 g** of Silver Chloride is produced. What amount (in mol) of Silver Nitrate should have reacted?

i). In another experiment, **1.0 L** of **0.20 M** Silver Nitrate reacts. What amount of Copper Chloride (in mol) should react?

Hint: Convert the Volume and Concentration into mol and then use the mol ratios to find n($CuCl_2$).

j). In another experiment, **100 mL** of **0.20 M** Copper Chloride reacts. What amount of Silver Nitrate (in mol) should react?

k). In another experiment, **200 mL** of **0.10 M** Copper Chloride reacts. What amount of Silver Chloride (in mol) should be produced?

l). In another experiment, **200 mL** of **0.10 M** Copper Chloride reacts. What mass of Silver Chloride should be produced?

m). In another experiment, **1.2×10^{22}** Copper Chloride molecules react. What amount of Silver Chloride (in mol) should be produced?

n). In another experiment, **3.0×10^{22}** Copper Chloride molecules react. What mass of Silver Chloride (in mol) should be produced?

ANSWERS: 1a). 58.5 g, 10 L. b). 0.010 mol, 10 mL. c). 0.090 mol, 3.6 g. d). 3.2 g, 0.080 M. e). 0.500 mol, 1.25 M. f). 0.24 mol, 4.1 g. 2a). 1.0 mol. b). 0.10 mol. c). 0.15 mol. d). 0.8 mol. e). 136 g. f). 20.17 g. g). 14.34 g. h). 0.01 mol. i). 0.10 mol. j). 0.04 mol. k). 0.04 mol. l). 5.74 g. m). 0.04 mol. n). 14.35 g.